Environmental Impact Assessment Report

Proposed Clonberne Wind Farm Development, Co. Galway

Chapter 8 – Land Soils and Geology

DOCUMENT DETAILS

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8. LAND SOILS AND GEOLOGY

8.1 Introduction

8.1.1 Background and Objectives

Hydro-Environmental Services (HES) was engaged by MKO to carry out an assessment of the potential likely and significant effects of the proposed Clonberne Wind Farm and Grid Connection (Proposed Project) on the Land, Soils and Geology aspects of the receiving environment.

The Proposed Project (Wind Farm site and Grid Connection) is described in full in Chapter 4 of this EIAR.

Where the 'Wind Farm site' is referred to, this refers to the 11 no. turbines and associated foundations and hard-standing areas, turbine delivery route (TDR) accommodation works, access roads, 2 no. temporary construction compounds, underground cabling, peat and spoil repository areas, wind farm drainage, tree felling, 1 no. borrow pit, peatland enhancement area and all ancillary works.

The "Grid Connection" relates to the ~2.8km underground 220kV Cabling Route, on-site 220kV substation, proposed access road, 2 no. new interface/end mast towers and all associated infrastructure.

Where 'the Site' is referred to, this relates to the primary study area for the Proposed Project EIAR, as delineated by the EIAR Site Boundary and includes both the Wind Farm site and Grid Connection.

This report provides a baseline assessment of the environmental setting of the Proposed Project, as described in Chapter 4, in terms of Land, Soils and Geology and discusses the potential likely and significant effects that the construction, operation and decommissioning of the Proposed Project will have. Where required, appropriate mitigation measures to avoid any identified significant effects to Land, Soils and Geology (i.e. natural resources) are recommended and the residual effects of the Proposed Project post-mitigation are assessed.

The Proposed Project study area with regard Land, Soils and Geology is defined by the EIAR Site Boundary.

8.1.2 Statement of Authority

Hydro-Environmental Services (HES) are a specialist geological, hydrological, hydrogeological and environmental practice which delivers a range of water and environmental management consultancy services to the private and public sectors across Ireland and Northern Ireland. HES was established in 2005, and our office is located in Dungarvan, County Waterford.

Our core areas of expertise and experience includes soils, subsoils and geology. We routinely complete impact assessments for land, soils and geology, hydrology and hydrogeology for a large variety of project types including wind farms and renewable energy projects.

This chapter of the EIAR was prepared by Michael Gill and David Broderick.

Michael Gill (P. Geo., B.A.I., MSc, Dip. Geol., MIEI) is an Environmental Engineer/Hydrologist with over 22 years' environmental consultancy experience in Ireland. Michael has completed numerous hydrological and hydrogeological impact assessments of wind farms in Ireland. He has also managed EIAR assessments for infrastructure projects and private residential and commercial developments. In addition, he has substantial experience in wastewater engineering and site suitability assessments, contaminated land investigation and assessment, wetland hydrology/hydrogeology, water resource

assessments, surface water drainage design and SUDs design, and surface water/groundwater interactions. For example, Michael has worked on the EIS/EIARs for Slievecallan Wind Farm, Cahermurphy (Phase I & II) Wind Farm, and Carrownagowan Wind Farm, and over 100 other wind farm related projects across the country.

David Broderick (P. Geo., BSc, H. Dip Env Eng, MSc) is a Hydrogeologist with over 17 years' experience in both the public and private sectors. Having spent two years working in the Geological Survey of Ireland working mainly on groundwater and source protection studies David moved into the private sector. David has a strong background in groundwater resource assessment and hydrogeological/hydrological investigations in relation to developments such as quarries and wind farms. David has completed numerous geology and water sections for input into EIARs for a range of commercial developments. David has worked on the EIS/EIARs for Ardderroo Wind Farm, Knockalough Wind Farm, and Oweninny Wind Farm, and over 60 other wind farm related projects across the country.

8.1.3 Relevant Legislation

The EIAR is prepared in accordance with the requirements of European Union Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (the 'EIA Directive') as amended by Directive 2014/52/EU. The requirements of the following legislation are complied with:

- Planning and Development Acts, 2000-2021;
- Planning and Development Regulations, 2001 (as amended);
- Directives 2011/92/EU and 2014/52/EU on the assessment of the effects of certain public and private projects on the environment;
- S.I. No. 296 of 2018 European Union (Planning and Development) (Environmental Impact Assessment) Regulations 2018;
- The Heritage Act 1995, as amended.

8.1.4 Relevant Guidance

The Land, Soils and Geology chapter of this EIAR was prepared in accordance with, where relevant, the guidance contained in the following documents:

- Environmental Protection Agency (2022): Guidelines on the Information to be contained in Environmental Impact Assessment Reports;
- Institute of Geologists Ireland (2013): Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements;
- National Roads Authority (2008): Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes;
- Guidelines for Planning Authorities and An Bord Pleanála on carrying out Environmental Impact Assessment (DoHPLG, 2018); and,
- Guidance on the preparation of the EIA Report (Directive 2011/92/EU as amended by 2014/52/EU), (European Commission 2017).

8.2 Assessment Methodology

8.2.1 Desk Study

A desk study of the Site was completed in advance of undertaking the walkover survey and site investigations. This involved collecting all relevant geological data for the Site and receiving environment. This included consultation with the following data sources:

- Environmental Protection Agency database (**www.epa.ie**);
- Geological Survey of Ireland - Groundwater and Geology Databases (**www.gsi.ie**);
- Geological Survey of Ireland – Geological Heritage site mapping (**www.gsi.ie**);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 14 (Geology of Galway Bay). Geological Survey of Ireland (GSI, 2004);
- Bedrock Geology 1:100,000 Scale Map Series, Sheet 12 (Geology of Longford/Roscommon). Geological Survey of Ireland (GSI, 2003);
- Geological Survey of Ireland (2003) – Clare-Corrib Groundwater Body Initial Characterization Reports;
- General Soil Map of Ireland 2nd edition (**www.epa.ie**); and,
- Aerial Photography, 1:5000 and 6 inch base mapping.

8.2.2 Baseline Monitoring and Site Investigations

A walkover survey, including geological mapping and investigations of the Site, were undertaken by David Broderick of HES (refer to Section 8.1.2 above for qualifications and experience) on 5th March, 10th & 11th May, 21st & 22nd June, 10th August, 21st December 2021, on 19th January and 6th April 2022 and on 28th March 2023.

A Peat Stability Risk Assessment and Peat Management Plan were undertaken by Gavin and Doherty Geosolutions (GDG, Feb 2024) for the Proposed Project.

The objectives of the intrusive site investigations included mapping the distribution and depth of peat and mineral subsoils at the Wind Farm site and Grid Connection along with assessing the mineral subsoil / bedrock conditions at key Proposed Project locations (i.e. proposed turbines, substation, 2 no. temporary construction compounds, existing and proposed access roads, borrow pit location, grid cable route and substation). This data was used to inform the final layout design.

Site investigations to address the Land, Soil and Geology section of the EIAR included the following:

- Walkover surveys and geological mapping of the Site area were undertaken to assess ground conditions;
- A total of 194 no. peat probes were undertaken by HES, MKO and GDG to determine the thickness and geomorphology of peat overlying parts of the Site;
- Trial pitting (15 no.) by GDG and gouge cores (10 no.) by HES to investigate soil, peat and mineral subsoil lithology;
- Investigation drilling (5 no. boreholes under supervision of HES) to determine the full geological profile of the Site (i.e. peat, mineral subsoil and bedrock profile) and groundwater conditions; and,
- Mineral subsoils and peat were logged according to BS: 5930 and Von Post Scale respectively.

The Peat Stability Risk Assessment Report and Peat Management Plan prepared by GDG are included as Appendix 8-1 and Appendix 4-3 of this EIAR, respectively.

8.2.3 Scope and Consultation

The scope for this chapter of the EIAR has also been informed by consultation with statutory consultees, bodies with environmental responsibility and other interested parties. This consultation process and the list of Consultees is outlined in Section 2.6 of this EIAR.

Due to the long duration of the Proposed Project pre-planning stage and alterations of the proposed layout over that period, scoping and consultation was carried out in 2020 and again in 2023.

Matters raised by Consultees in their responses with respect to the water environment are summarised in Table 8-1 below.

Table 8-1 Summary Scoping Responses

Consultee	Matters Raised - Description	Addressed in Sections
Geological Survey of Ireland (2020 & 2023)	*"With the current plan, there are no envisaged impacts on the integrity of the current CGSs by the proposed development. We ask that any proposed activities such as construction and modification of access roads and additional traffic due to access road construction and turbine installation in the area associated with the wind farm development do not impact on the CGSs. If the proposed development plan is altered, please contact GSI Planning (GSIPlanning@gsi.ie) for further information and possible mitigation measures if applicable".*	n/a

8.2.4 Impact Assessment Methodology

Using information from the desk study and data from the site investigations, an assessment of the importance of the land, soil and geological environment within the EIAR Site Boundary is assessed using the criteria set out in Table 8-2 (NRA, 2008).

Table 8-2 Estimation of Importance of Soil and Geology Criteria (NRA, 2008).

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying route is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying site is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes Geological feature of high value on a local scale (County Geological Site). Well drained and/or highly fertility soils. Moderately sized existing quarry or pit Marginally economic extractable mineral resource.
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft	Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed Wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit.

Importance	Criteria	Typical Example
	organic soil underlying site is moderate on a local scale.	Sub-economic extractable mineral Resource.
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying site is small on a local scale.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral Resource.

The guideline criteria (EPA, 2022) for the assessment of likely significant effects require that likely effects are described with respect to their extent, magnitude, type (i.e. negative, positive or neutral) probability, duration, frequency, reversibility, and transfrontier nature (if applicable). The descriptors used in this environmental impact assessment report are those set out in the EPA (2022) Glossary of effects as shown in Chapter 1 of this EIAR. In addition, the two impact characteristics proximity and probability are described for each impact and these are defined in Table 8-3.

In order to provide an understanding of this descriptive system in terms of the geological/hydrological environment, elements of this system of description of effects are related to examples of potential likely significant effects on the geology and morphology of the existing environment, as listed in Table 8-4.

Table 8-3: Additional Impact Characteristics.

Impact Characteristic	Degree/ Nature	Description
Proximity	Direct	An impact which occurs within the area of the proposed project, as a direct result of the proposed project.
	Indirect	An impact which is caused by the interaction of effects, or by off-site developments.
Probability	Unlikely	A low likelihood of occurrence of the impact.
	Likely	A medium likelihood of occurrence of the impact.

Table 8-4: Impact descriptors related to the receiving environment.

Impact Characteristics		Potential Hydrological Impacts
Quality	Significance	
Negative only	Profound	Widespread permanent impact on: › The extent or morphology of a cSAC. › Regionally important aquifers. › Extents of floodplains. Mitigation measures are unlikely to remove such impacts.

Impact Characteristics		Potential Hydrological Impacts
Quality	Significance	
Positive or Negative	Significant	Local or widespread time-dependent impacts on: › The extent or morphology of a cSAC / ecologically important area. › A regionally important hydrogeological feature (or widespread effects to minor hydrogeological features). › Extent of floodplains. Widespread permanent impacts on the extent or morphology of an NHA/ecologically important area. Mitigation measures (to design) will reduce but not completely remove the impact – residual impacts will occur.
Positive or Negative	Moderate	Local time-dependent impacts on: › The extent or morphology of a cSAC / NHA / ecologically important area. › A minor hydrogeological feature. › Extent of floodplains. Mitigation measures can mitigate the impact OR residual impacts occur, but these are consistent with existing or emerging trends
Positive, Negative or Neutral	Slight	Local perceptible time-dependent impacts not requiring mitigation.
Neutral	Imperceptible	No impacts, or impacts which are beneath levels of perception, within normal bounds of variation, or within the bounds of measurement or forecasting error.

8.2.5 Limitations and Difficulties Encountered

No limitations or difficulties were encountered during the preparation of the Land, Soils and Geology Chapter of this EIAR. The site investigations and follow up monitoring carried out were thorough and exhaustive.

8.3 Existing Environment

8.3.1 Site Description and Topography

The Site, which is 353ha in area, comprises areas of cutover bog, forestry and agricultural grassland located approximately 0.7km to the west of Clonberne Village, Co. Galway.

Approximately 46% of the Wind Farm site is agricultural land, 40% bog and 14% coniferous forestry. The majority of the northern half of the Wind Farm site is grassland while the southern half is mainly bog. It's likely a large proportion of the agricultural land was also originally bog. The forestry is present as small, fragmented plantations across the Wind Farm site.

Peat cutting in the form of private turbary plots is widespread across the bogs along with some peat harvesting of the bogs at the west and southeast of the Wind Farm site. There are also several separate farmsteads within the Wind Farm site.

The topography of the Wind Farm site is undulating with gentle to moderate slopes typical of a low-lying raised bog setting with local hills. The elevation of the Wind Farm site ranges from approximately 65mOD to 80mOD, with the overall slope to the west /southwest. The lower parts of the Wind Farm site are on the west and the southwest and this is also where most of the bog coverage is. The higher elevated part of the Wind farm site on the north /northeast is mainly undulating grassland.

The Wind Farm site is currently accessible via network of local public roads, bog roads and farms tracks. The proposed entrance to the Wind Farm site is off the R328 which borders the Site to the north. Approximately 1km of existing bog roads and farms tracks will be upgraded as part of the Proposed Project.

With regard the main elements of the proposed Wind Farm site infrastructure, proposed turbine locations T6, T7, T10 and T11 are located on cutover raised bog, proposed turbine locations T1, T2, T4, T5 and T9 are located on grassland, while turbines T3 and T8 are in forestry (on peat).

The proposed 1 no. borrow pit is in an area of grassland on the far west of the Wind Farm site. The proposed temporary construction compounds (2 no.), located on the north and south of the Site are in grassland and on bog respectively. The proposed 4 no. peat repositories areas are located on cutover bog while the 1 no. repository area is located on grassland.

The proposed peatland enhancement area is a ~11.6ha portion of a raised bog on the south of the Wind Farm site that has been drained and cutaway along its western and northern edges. This area of drained bog is proposed for rewetting as part of the Proposed Project.

The underground Grid Connection 220kV cabling route, which measures approximately 2.8km in length, will connect into the existing Cashla – Flagford 220kV overhead line at Laughil, located 1.4km to the southeast of the Wind Farm site. The proposed on-site 220kV substation is located on the edge of the bog on the far south of the Wind Farm site.

On leaving the proposed substation location, the cabling route crosses cutover bog for approximately 1.4km before exiting the Wind Farm site. The route then follows public roads for 1.4km before reaching the proposed 2 no. end mast locations within grassland areas at Laughil townland.

TDR road upgrade works are required at 3 no. road junctions located approximately 4.5km to the northwest of the Wind Farm site. Junction works are required on the N83, R328 and on the L6466 local road junction.

8.3.2 Land and Landuse

Based on the Corine 2018 land cover mapping, the Site comprises peat bogs, agricultural pastures and mixed forests. The Grid Connection follows public roads for approximately 1.4km.

As discussed above, the peat bogs are used for small to medium scale peat cutting. The agricultural lands are primarily used for cattle grazing while the forestry is mainly coniferous or mixed.

8.3.3 Soils and Subsoils

8.3.3.1 GSI Mapping

Based on the Teagasc soils mapping (www.gsi.ie), the Wind Farm site is predominantly covered by cutaway/cutover peat and peaty poorly drained mineral soil (BminPDPT) along with some localised

deep well drained mineral soil (BminDW). Geomorphologically, the peat at the Site is raised bog, also known as basin peat.

The majority of the grassland and forestry areas within the Wind Farm site are mapped to have BminPDPT soil. Deep well drained mineral soils are limited to a small area on the north-east of the Wind Farm site, which comprises grassland.

The GSI subsoils map (www.gsi.ie) also shows that the Wind Farm site has a large coverage of cutover raised peat (67%) which in turn is surrounded predominately by limestone tills (30%). An isolated pocket of limestone gravels is mapped in the central area of the Wind Farm site and also at the area of the proposed borrow pit (3%). The GSI mapped cutover bogs areas also includes areas of grasslands which suggests these grassland areas are improved/reclaimed.

Based on the GSI subsoils mapping, proposed turbine locations T2 and T9 are located on limestone tills and the other no. 9 proposed turbines are located on cutover raised peat. All proposed 4 no. peat repositories and the 1 no. spoil deposition area are also located on cutover raised peat.

With regard the Grid Connection, the proposed substation is mapped to be underlain by limestone tills including the section of grid cable along public roads and 2 no. end masts. The section of grid cable within the Wind Farm site is mapped mainly as cutover raised peat.

The GSI subsoils maps is shown as Figure 8-1 below.

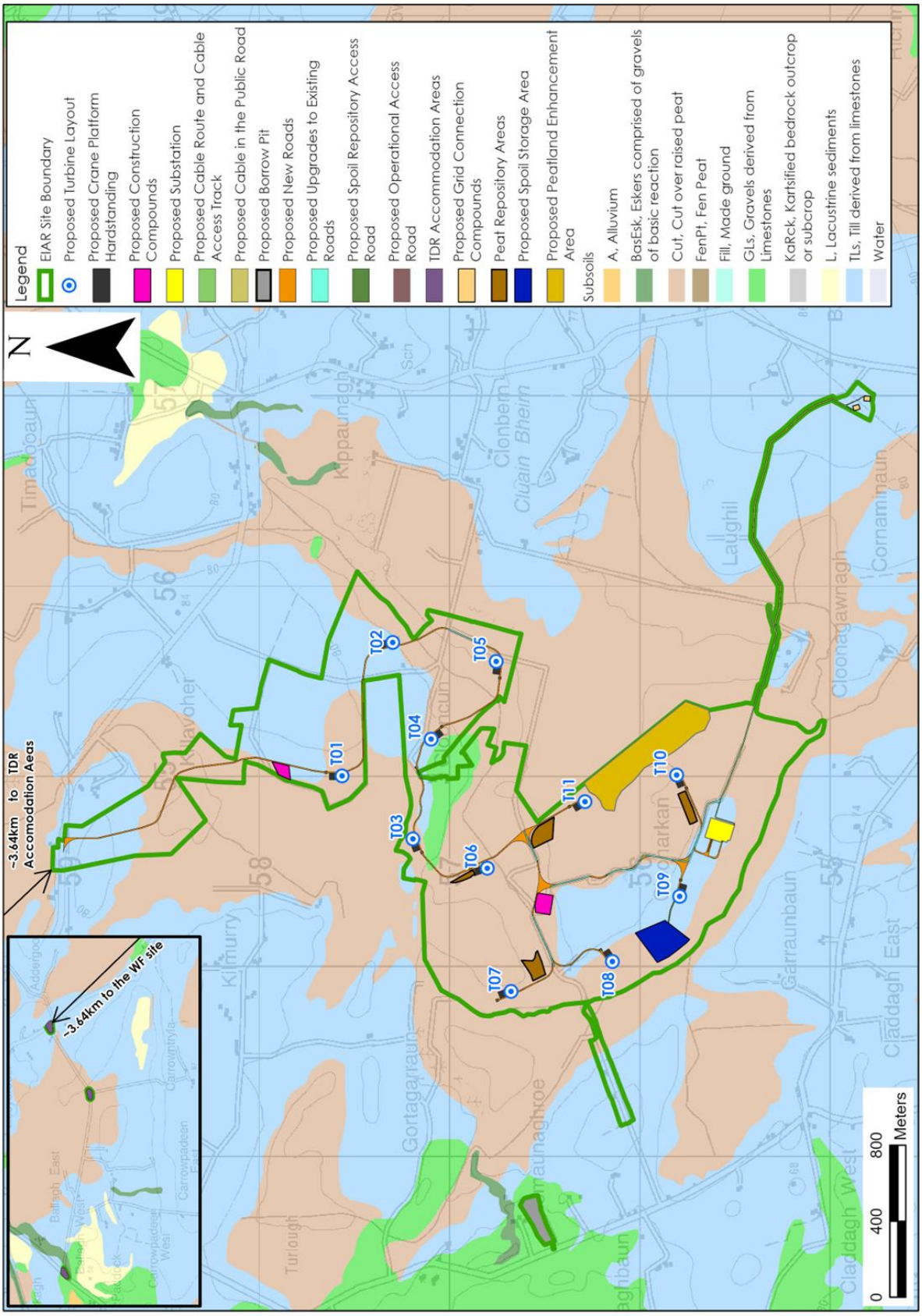

Figure 8-1 Local Subsoils Map

8.3.3.2 Peat Depth Probing

The peat thickness encountered by probing across the Site varies from 0m to a maximum of 6.65m, with an average of 1.68m recorded. A total of no. 194 peat probes were carried out at the Site.

The frequency of different peat thicknesses is shown in Figure 8-2 below. In total, 69.9% of recorded peat thicknesses were under 1m, and 85.6% were under 2m (GDG, 2024). A summary peat depth map is shown as Figure 8-3 below.

Laterally extensive regions of >2m in depth were encountered in high raised bog settings, particularly to the east of turbine location T7, south of T11, northeast of T10, west of T6, and between T1 and T3.

Areas of deeper peat are restricted to discrete raised intact bogs, which have been avoided by all major infrastructure locations. The depths encountered are considered moderate to deep in places, with probes identifying peat thicknesses of up to 6.65m in areas of intact peat.

Proposed turbine locations T1, T2, T4, T5 and T9 are located in grassland areas with no peat or thin peat (<1m). Much of the remaining proposed infrastructure, including T6 &T7, T10 &T11, and the construction compounds, are located in areas of cut-over peat, where turbary peat harvesting has removed significant quantities of peat, reducing peat thicknesses. T3 and T8 are located in areas of forestry, planted over peat of up to 2m thickness.

A summary peat depth at the Proposed Project key infrastructure locations is shown in Table 8-6 below.

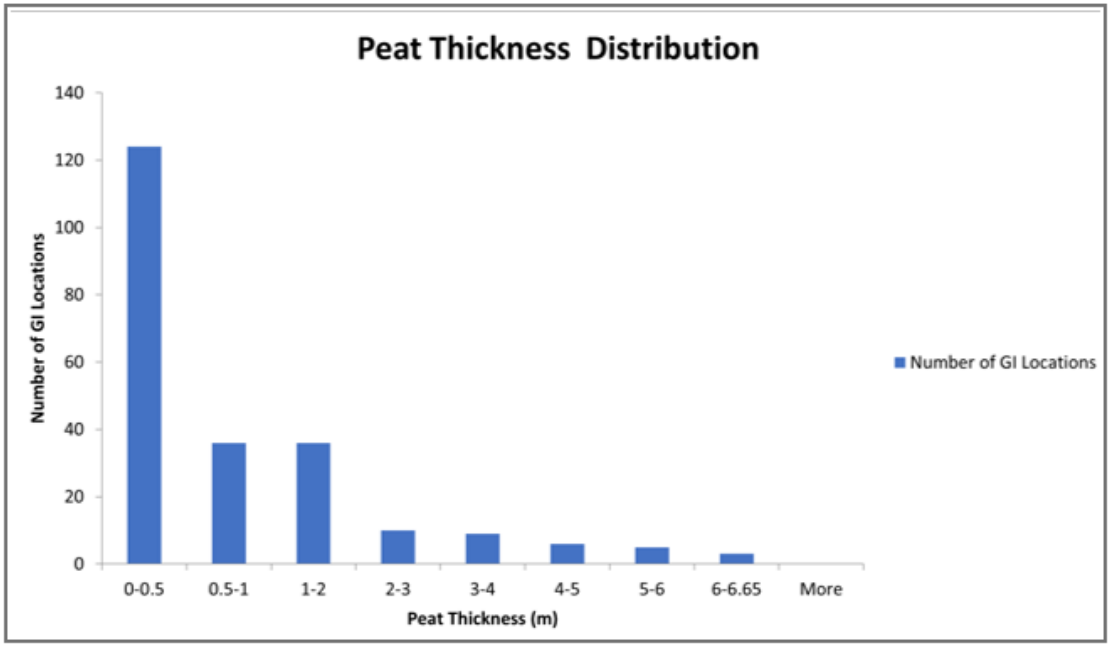

Figure 8-2 Peat Thickness Distribution (GDG, 2024)

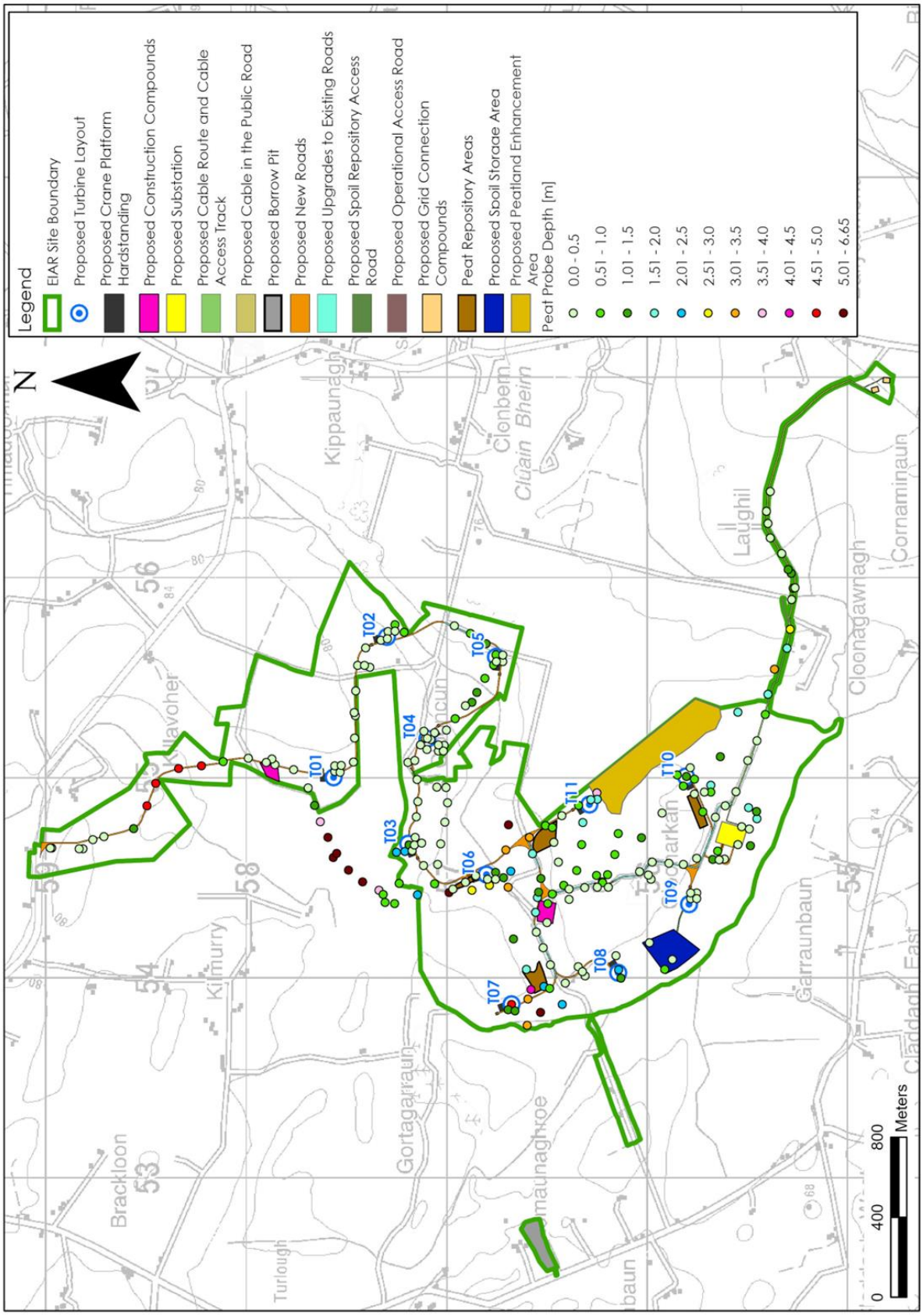

Figure 8-3 Summary Peat Depth Map

8.3.3.3 Site Investigations (Drilling and Trial Pitting)

Extensive ground investigations were carried out between 2020 and 2022 to determine the geological and hydrogeological setting of the Site.

The drilling investigations in particular were focused in the area where the Gurteen/Cloonmore Group Water Scheme Source Protection Area overlaps with the Wind Farm site (refer to Chapter 9 – Water for details). Borehole logs are attached as Appendix 8-2.

In order to determine the full geological profile (soil/peat, subsoil and bedrock) at the Site, particularly in the area of the mapped source protection area, 10. Soil gouge cores, 15 no. trial pits and 5 no. bedrock boreholes (BHs) were carried out. The locations of the investigation points are shown on Figure 8-4. Refer to Table 8-5 for a summary of the investigation drilling.

In the cutover raised bog areas, the peat was found to be directly underlain by up to 1.3m of shell marl at the investigation locations. The shell marl layer is also visible on the bed and banks of the main streams (i.e. Stream A and Stream B as referred to in Chapter 9) that flow close to the bog in the area near proposed turbine locations T6 and T7. Shell marl was confirmed below the peat at turbine locations T6, T7, T10 and T11 which are located on cutover raised bog.

Shell marl is a pale brown-whitish coloured calcareous deposit formed in freshwater lakes and composed largely of uncemented mollusc shells and precipitated calcium carbonate and is commonly found below basin peat.

Investigation drilling in the area of the cutover bog encountered between 9.7m (BH1) and 15.5m (BH3) of CLAYs and SILTs (glacial deposits) below the peat and shell marl layer. The mineral subsoil / bedrock interface below the cutover bog was met at elevations of between 50.99m OD (BH2) and 58.05m OD (BH3).

Outside of the peat bogs limestone till deposits are dominant over the rest of the Wind Farm site (i.e. grassland areas). The investigations show that mineral subsoils in the grassland areas typically comprise gravelly CLAY or gravelly SILT over SAND or GRAVEL with cobbles and boulders.

The confirmed depth of glacial tills in grassland areas on the north of the Site is between 5.7m (BH5) and 13.8m (BH4). BH3 is the most southerly positioned borehole at the Site where 15.5m of glacial deposits were encountered at this location. BH3 is located on the edge of the bog where there is a transition into grassland to the south.

There are drilling logs available for 2 no. existing investigation holes located in the area of the proposed borrow pit (EH1 and EH3) which is situated on slightly elevated grassland (80 – 85m OD) on the west of the Wind Farm site. Overburden depths up to 5.6m were reported in the driller's logs.

Bedrock was not confirmed in any of the 15 no. trial pits carried out at the Site (termination depths of trial pits were up to 3.5mbgl – metres below ground level). Trial pit logs are attached to the Peat Stability Risk Assessment Report (Appendix 8-1).

Table 8-5: Summary of Investigation Drilling

Location	Ground Level (m OD)	Depth to Bedrock (m)	Peat Thickness & Marl (m)	Glacial Till Thickness (m)	Glacial Till Description
BH1	66.425	13.2	3.5	9.7	Silty CLAY
BH2	66.298	15.3	3.2	12.1	Silty sandy CLAY
BH3	74.551	16.5	1	15.5	Gravelly SILT/CLAY
BH4	74.558	14.6	0	13.8	S&G, SILT & CLAY
BH5	70.540	6.0	0	5.7	SAND & CLAY

A summary of the site investigations finding at key development locations at the Site are shown below in Table 8-6.

Table 8-6: Summary of Peat Depths and Mineral Subsoil Lithology at Proposed Project Locations

Probe ID	Site Investigation ID	Probe Average Peat Depth (m)	Total Depth to Bedrock (mbgl)	Summary of Mineral Subsoil Lithology
WIND FARM SITE				
T1	TP06	0.3	>2.3	Sandy, gravelly CLAY over Clayey SILT with cobbles and boulders
T2	TP07/BH5	0.9	6.0	Silty CLAY with cobbles
T3	BH4	1.03	14.6	SAND and GRAVEL over SILT and CLAY
T4	TP08	0	>2.6	Sandy, gravelly CLAY over gravelly SAND over sandy GRAVEL with cobbles and boulders
T5	TP09	0.68	>2.8	Gravelly sandy CLAY over sandy GRAVEL with cobbles and boulders
T6	BH2/GC_T6	0.64	15.3	Soft Shell Marl over Soft to Firm CLAY
T7	BH1/GC_T7	4.4	13.2	Soft Shell Marl over Soft to Firm CLAY
T8	TP01	1.8	>2.5	Gravelly CLAY over SAND with cobbles and boulders
T9	TP11	0.09	>2.9	Gravelly CLAY with cobbles and boulders
T10	GC_T10	1.5	>2.0	Soft Shell Marl over Soft to Firm CLAY
T11	GC_T11	1.5	>2.0	Soft Shell Marl over Soft to Firm CLAY
Borrow Pit	EH1 & EH3	0	2 – 5.6	Gravelly, sandy SILT/CLAY (Limestone tills & Sand & Gravels)

Probe ID	Site Investigation ID	Probe Average Peat Depth (m)	Total Depth to Bedrock (mbgl)	Summary of Mineral Subsoil Lithology
Northern Construction Compound	TPr02	0.3	>2.25	Sandy gravelly CLAY over sandy silty GRAVEL
Southern Construction Compound	BH2	0.7	15.3	Soft Shell Marl over Soft to Firm CLAY
GRID CONNECTION				
Substation	TP02	0	>3.5	Sandy gravelly CLAY over gravelly SAND
Grid Connection Cable	Refer to PSRA	2.3	>2	Soft SILT/CLAY
End Masts	GC_EM	0	-	SILT/CLAY (limestone tills)

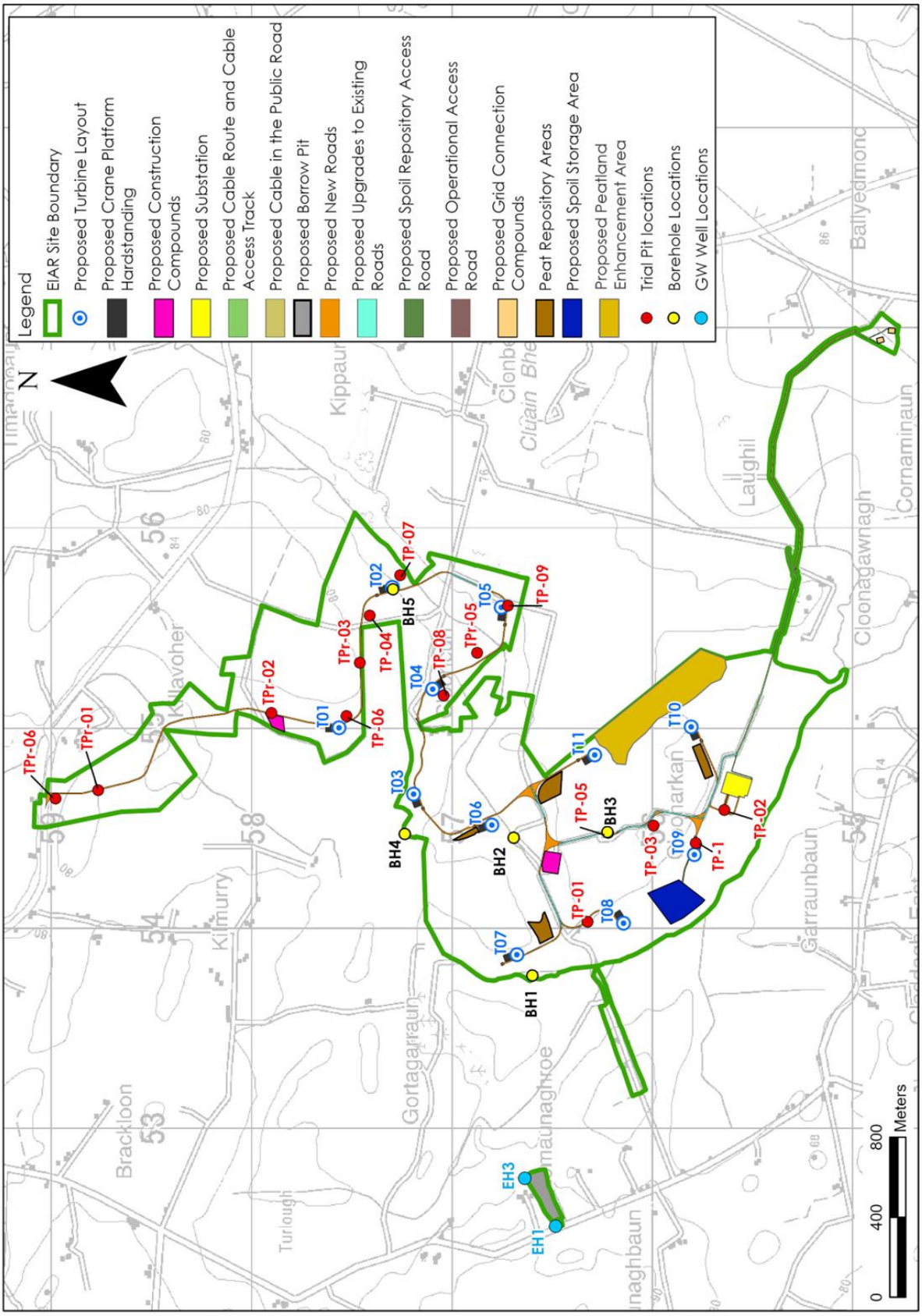

Figure 8-4 Site Investigation

8.3.4 Bedrock Geology

8.3.4.1 GSI Mapping

The underlying bedrock strata at the Proposed Project site is mapped by the GSI as the Burren Formation which is a pure bedded limestone.

The formation is typified by pale-grey packstones and wackestones, but also contains intervals of dark cherty limestones, often associated with oolitic grain stones.

The Burren Formation is susceptible to Karstification which is a process whereby fissures, faults and joints in the purer units of the limestone are enlarged by dissolution. There are no exposures of bedrock at the Proposed Project site, as the area is covered by peat and/or deep glacial tills as described above.

Based on the GSI karst database, the closet karst feature to the Proposed Project site is a spring at Gortagarraun, which is located just outside the western boundary of the Wind Farm site. The spring is the source of the Gurteen/Cloonmore Group Water Scheme, which is discussed more in Chapter 9 (Water Chapter).

Other karst features within 1.5km of the Proposed Project site include a turlough to the northwest and a swallow hole to the east/northeast. Both these features are discussed more in Chapter 9. No karst features were observed within the Proposed Project site during the walkover surveys.

See section below with regard evidence of Karstification in the underlying bedrock.

A bedrock geology map is shown as Figure 8-5 below.

8.3.4.2 Investigation Drilling

The depth to limestone bedrock at the Site ranged between 6m (BH5) and 16.5m (BH3) at the 5 no. drilling locations. Top of bedrock elevation at the Site ranges between 50.99m OD (BH2) and 64.54m OD (BH5). Top of bedrock elevation is lowest below the bog in the area of BH1 and BH2 and highest in the grassland area on the northeast of the Site (BH5).

The limestone bedrock at the Site varies from strong competent limestone to very weathered limestone and with some clay infilled fractures. Bedrock heterogeneity is a typical feature of karstified limestone; however, a notable pattern in bedrock quality did emerge from the 5 no. drilling locations.

The bedrock at the boreholes carried out in the bog areas (BH1, BH2 and BH3) was notably more weathered and karstified than the boreholes carried out in grassland areas (i.e. BH4 and BH5). The bedrock at BH4 and BH5 was generally strong, competent with few fractures.

The northern portion of the Site, which is more elevated than the southern portion appears to be underlain by very competent limestone based on the drilling done to date.

There are drilling logs available for 2 no. existing investigation holes located in the area of the proposed borrow pit (EH1 and EH3) which is situated on slightly elevated grassland (80 – 85m OD) on the west of the Wind Farm site. The proposed depth of the borrow pit is between 7 and 13m below ground level (mbgl) to put the findings of the investigation holes into context.

The drilling logs shows solid, competent, dry limestone down to a depth of approximately 25mbgl. Some isolated fractures were recorded below 25mbgl.

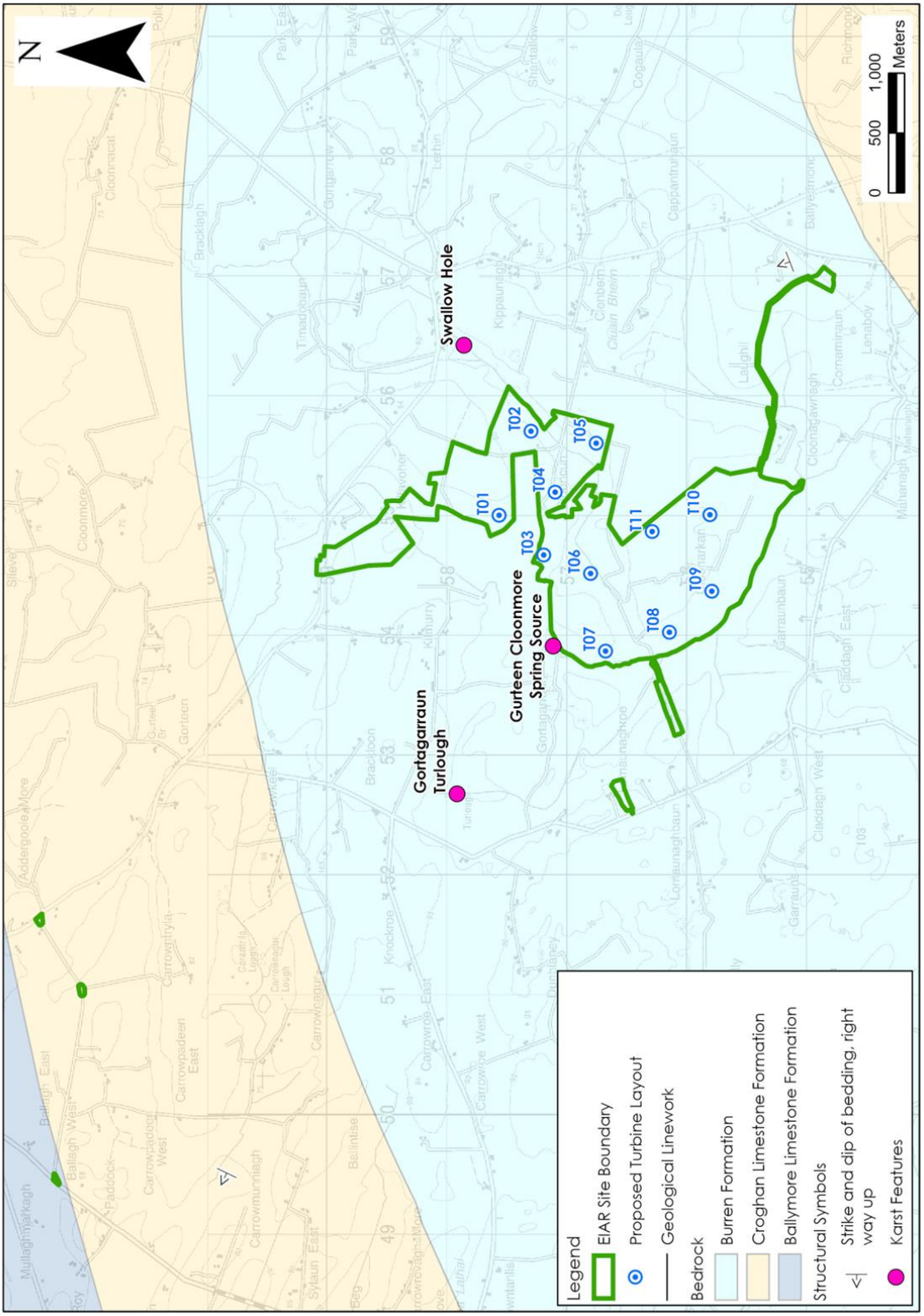

Figure 8-5 GSI Bedrock Geology Map

8.3.5 Geological Resource Importance

The limestone bedrock at the Proposed Project site is classified as "Low" importance. The bedrock could be used on a "sub-economic" local scale for construction purposes. The bedrock in the area is poorly exposed due to the coverage of deep peat and limestone tills.

The peat deposits at the Proposed Project site can be classified as "Low" importance as the peat is not designated in this area and is significantly degraded in most places by peat cutting and drainage. Similar peat deposits are also locally abundant in the study area. Refer to Table 8-7 for classification criteria.

8.3.6 Geological Heritage & Designated Sites

The closet designated site to the Proposed Project is Lough Corrib SAC which incorporates a stream (Levally Stream) which flows immediately to the southeast of the Proposed Project site.

The Grid Connection cable route intercepts the SAC for about 160m as the route goes over an existing bridge crossing on the Levally Stream. The closest turbine to the SAC (T10) is 0.6km away. The majority of the Proposed Project site drains to the Levally Stream which is discussed in more detailed in Chapter 9 (Water Chapter) with regard potential indirect effects.

The nearest Geological Heritage site to the Proposed Project site is Levally Lough (turlough), located ~2km to the southwest of the Proposed Project site.

Potential hydrological/hydrogeological effects on Lough Corrib SAC and Levally Lough SAC are discussed in Chapter 9 (Hydrology/hydrogeology).

All designated sites and geological heritage sites are screen out for further assessment with regard land, soils and geology due to lack of potential direct effects. Indirect hydrological and hydrogeological effects are assessed in Chapter 9 (Water).

8.3.7 Soil Contamination

There are no known areas of soil contamination on the Proposed Project site. During the site walkovers or investigations, no areas of contamination concern were identified. This was also confirmed by the groundwater sampling and laboratory analysis conducted on the investigation boreholes (refer Water Chapter 9).

According to the EPA online mapping (http://gis.epa.ie/Envision), there are no licensed waste facilities on or within the immediate environs of the site of the Proposed Project.

There are no historic mines at or in the immediate vicinity of the site of the Proposed Project that could potentially have contaminated tailings.

8.3.8 Economic Geology

The GSI online Aggregate Potential Mapping Database shows that the Proposed Project site is located within an area mapped as being typically Very Low to Low in terms of crushed rock aggregate potential and with no potential for granular aggregate potential (i.e. potential for gravel reserves).

8.3.9 Geohazards

The GSI Landslide database (www.gsi.ie) does not record any historic landslides in the vicinity of the Site or in the surrounding lands.

The GSI Landslide Susceptibility Map (www.gsi.ie) classifies the probability of a landslide occurring at a given location. The probability of a landslide occurring at the Proposed Project site is mapped as being mainly Low. Refer to Section 8.3.10 below for the Peat Stability Risk Assessment.

8.3.10 Peat Stability Risk Assessment

8.3.10.1 Introduction

Gavin and Doherty Geosolutions (GDG) were engaged to undertake a Peat Stability Risk Assessment of the Proposed Project site. A Peat Stability Risk Assessment Report (GDG, 2024) is attached as Appendix 8-1. This section of the chapter is a summary of the Peat Stability Assessment Report carried out by GDG.

Hydrological, hydrogeological and ecological factors were considered in the Peat Stability Risk Assessment Report, and regular interaction between HES and MKO were undertaken throughout the iterative design process (i.e. hydrological constraints mapping etc). The assessment was done in accordance with Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (PLHRAG, Scottish Government, 2017).

A constraints study was initially undertaken by the Environmental (MKO), Hydrological (HES) and Ecological (MKO) members of the project design team to determine the developable area on the Site, prior to the site reconnaissance by engineering geologists/geotechnical engineers from GDG.

8.3.10.2 Peat Stability Desk Study

The GSI landslide inventory (GSI, 2022a), the multi-temporal aerial / satellite imagery, the DEM, the landslide susceptibility map (GSI, 2016), and the rainfall information of Met Éireann data 1981-2010 were used for this part of the desk study.

The GSI mapping depicts the spatial relationship between records of previous landslide events (GSI, 2022a, 2022b) and rainfall across Ireland from the Met Éireann (2018) average annual rainfall dataset. The study area is in a region of moderately high rainfall and relatively flat topography. According to the GSI landslide inventory (GSI, 2022), the closest landslide is located around 5.3 km northeast of the closest turbine (T01) and around 3.9km from the Site boundary.

The area of the peat slide was not recorded, but it is recorded to have occurred in 1873 and “moved quickly first and continued slowly for 11 days” (Praeger, 1893). This landslide resulted in the peat "burying three farmhouses and covering about 300 acres of pasture and arable land, 6 feet deep". Little other information is available, but this location appears to be a relatively flat, deep raised peat bog, and therefore, the failure mechanism was likely a margin rupture (Warburton et al. 2004) triggered bog burst event caused by the extraction of peat from the raised bog due to steep cuttings (7-9m high), removing toe support for the high raised bog.

The GSI Landslide Susceptibility Map (www.gsi.ie) classifies the probability of a landslide occurring. This map was obtained by using an empiric probabilistic method at a regional scale and did provide input into site-specific scale engineering studies. Most of the Site is mapped as having low susceptibility due to the low slope angles encountered. Small zones of moderately low susceptibility are mapped at the Site's west, east, and north ends, where no developments are proposed.

8.3.10.3 Peat Stability Investigations

A walkover including intrusive peat depth probing, an intrusive ground investigation comprising trial pit and a stability analysis and risk assessment was carried out by GDG to assess the susceptibility of the Proposed Project site to peat failure following the principles in PLHRAG.

The assessment involved slope stability analysis at 194 locations across the Proposed Project site. The peat depth distribution across the Site is discussed in Section 8.3.3.2 above.

8.3.10.4 Peat Stability Analysis

The purpose of the analysis was to determine the Factor of Safety (FoS) of the peat slopes. The minimum required Factor of Safety (FoS) is 1.3 based on BS6031:1981: Code of Practice for Earthworks (BSI, 2009).

GDG have completed an analysis of peat sliding at all the main Proposed Project infrastructure locations (Wind Farm site and Grid Connection) for both the undrained and drained conditions as explained further below.

The factor of safety provides a direct measure of the degree of stability of a slope by the ratio of the shear resistance along a potential surface of failure and the landslide driving forces acting on such surface. Multiple potential surfaces of failure are possible, but the FoS assigned to a slope is that of the surface of failure with the lowest value of FoS:

- FoS < 1 indicates a slope is unstable and prone to failure.
- FoS = 1 indicates a slope is theoretically stable but not safe.
- FoS ≥ 1.3 indicates the acceptable safety threshold. The previous code of practice for earthworks BS 6031:1981 (BSI, 1981) provided advice on the design of earthworks slopes. It stated that for a first-time failure with a good standard of site investigation, the design FoS should be greater than 1.3. This way, the slope is stable and safe.

Table 8-7: Probability Scale for Factor of Safety.

Factor of Safety limits	Slope stability
FoS < 1	Unstable
1 ≤ FoS <1.3	Stable but not safe
FoS ≥ 1.3	Stable and safe

8.3.10.5 Peat Stability Assessment Results

Stability of a peat slope is dependent on several factors working in combination. The main factors that influence peat stability are slope angle, shear strength of peat, depth of peat, pore water pressure and loading conditions.

An adverse combination of factors could potentially result in peat sliding. An adverse condition of one of the above-mentioned factors alone is unlikely to result in peat failure. The infinite slope model (Skempton and DeLory, 1957) is used to combine these factors to determine a factor of safety for peat sliding. This model is based on a translational slide, which is a reasonable representation of the dominant mode of movement for peat failures.

To assess the factor of safety for a peat slide, an undrained[1] (short-term stability) and drained (long-term stability) analysis has been undertaken to determine the stability of the peat slopes on-site.

- The undrained loading condition applies in the short-term during construction and until construction induced pore water pressures dissipate.
- The drained loading condition applies in the long-term. The condition examines the effect of in particular, the change in groundwater level as a result of rainfall on the existing stability of the natural peat slopes.

As mentioned above, the Peat Stability Risk Assessment Report (GDG, 2024) is attached in Appendix 8-1.

8.3.10.5.1 *Undrained Analysis*

The results of the undrained analysis for the peat at the Proposed Project site infrastructure locations are presented in Table 8-8. The undrained analysis was undertaken for 2 no. conditions: Condition 1 with no surcharge loading and Condition 2 with a surcharge loading of 10kPa, equivalent to 1m of stockpiled peat.

The FoS has also been calculated semi-automatically in Geographical Information Systems for the entire site (the methodologies are detailed in Appendix 8-1) and provides an FoS for other features such a hardstands areas and access roads.

The spatial distribution of the FoS values for Condition 1 show almost all investigation locations to be stable and safe (FoS > 1.3, green). There are some small areas beside the cable access track and the T7 hardstand which show FoS values between 1 and 1.3 (yellow: stable but not safe).

For Condition 2 almost all investigation locations are shown to be stable and safe (FoS > 1.3, green), but there are some small areas beside the cable access track and the T7 hardstand which show FoS values <1 (red: not stable).

These risk areas are caused by localised factors which have been examined in more detail in Section 0 of the Peat Stability Risk Assessment Report. Where required additional mitigation, including exclusion zones and peat management restriction areas have been scheduled which the designer and contractor must adhere to at the construction stage.

[1] *For the stability analysis two load conditions were examined, namely:*

Condition (1): no surcharge loading
Condition (2): surcharge of 10 kPa, equivalent to 1 m of stockpiled peat assumed as a worst case.

Table 8-8: Factor of Safety Results (undrained condition)

Turbine No./Waypoint	Factor of Safety for Load Condition	
	Condition (1)	Condition (2)
T1	49.42	12.02
T2	151.31	12.32
T3	62.12	31.61
T4	3968.94	12.80
T5	9.22	3.72
T6	76.83	30.10
T7	1.03	0.84
T8	7.06	4.53
T9	453.41	35.59
T10	20.17	11.94
T11	12.91	7.82
C. Compound (North)	29	6.69
C. Compound (South)	22.75	9.37
Substation	20.51	5.86
Peatland Enhancement area	9.23	7.34
Grid Connection	3.99	2.81
PRA1	34.11	14.05
PRA2	14.48	7.58
PRA3	9.3	6.4
PRA4	179.06	51.16
SRA	42.15	12.04

Note: PRA – Peat Repository Area, SRA - Spoil Repository Area

8.3.10.5.2 Drained Analysis

Drained analysis results are presented in Table 8-9. As outlined above, the drained loading condition applies in the long-term. The condition examines the effect of in particular, the change in groundwater level as a result of rainfall on the existing stability of the natural peat slopes.

For Condition 1 almost investigation locations are shown to be stable and safe (FoS > 1.3, green), but there are some small areas beside the cable access track and the T7 hardstand which show FoS values <1 (red: not stable).

The calculated FoS for Condition 2 are in excess of 1.30 for all Proposed Project locations assessed, indicating stable and safe.

Table 8-9: Factor of Safety Results (drained condition)

Turbine No./Waypoint	Factor of Safety for Load Condition	
	Condition (1)	Condition (2)
T1	39.83	20.88
T2	121.30	21.36
T3	50.89	55.39
T4	3175.39	22.16
T5	7.49	6.47
T6	62.39	52.52
T7	0.90	1.51
T8	5.88	8.00
T9	363.45	61.72
T10	16.69	21.01
T11	10.70	13.78
C. Compound (North)	23.36	11.61
C. Compound (South)	18.50	16.35
Substation	13.07	8.02
Peatland Enhancement Area	8.05	13.25
Grid Connection	3.51	5.14
PRA1	27.74	24.52
PRA2	11.88	13.29

Turbine No./Waypoint	Factor of Safety for Load Condition	
	Condition (1)	Condition (2)
PRA3	7.83	11.34
PRA4	144.58	89.02
SRA	34.04	20.95

Note: PRA – Peat Repository Area, SRA - Spoil Repository Area

8.3.10.5.3 *Assessment and Interpretation of FoS Results*

The interpretation of the factor of safety analysis and accurate assessment of the peat stability conditions is a semi-automated approach that combines the developed polygon areas of the FoS results, areas of risk identified during the site walkovers, and potential risk areas identified from the examination of peat depths and site topography. It is noted that the results from all FoS analyses (drained/undrained, with and without surcharge) are used, highlighting any areas indicative as having a FoS of less than 1.3 in the worst-case surcharged condition with 10kPa. These areas were then cross-examined with the observations from the site visits and topographic models.

This analysis was used throughout the development process to aid in the siting and design of the proposed project layout including turbines, hardstands, and other key infrastructure locations. The undrained scenario with a 1m peat surcharge has been considered as the critical scenario. However, the FoS of all elements of the site was examined in both the drained and undrained conditions.

The foundation and hardstand at T7 overlap with an area of FoS <1 in the undrained and drained scenarios without surcharge. This area of low FoS is linear, running N-S and then W-E along a peat-cutting face. This low FoS is driven by locally thick peat (up to 5m thick) and locally steep slope angles calculated at peat cuttings. Analysis of the aerial imagery (Section 2.6 of PSRA Report) suggests that the present peat-cutting face is, in reality, 30m further east than the locally steep slope angles derived from the topographic data. This suggests that peat cutting in the area has progressed since the topographic was captured and that the peat-cutting face no longer crosses the T7 foundation or hardstand, reducing the risk at this location. This is confirmed by site observations, which show that the peat cut face no longer interacts with the turbine location. The hardstand orientation was also flipped to avoid intact peat (mitigation by design).

Much of the Proposed Project site contains flat-lying, deep peat with active peat cutting. Steep peat cuttings of <1m generate low factors of safety but are considered to be generally of low landslide risk. Raised bog environments like this site may be susceptible to bog burst type failures, which can occur at very low slope angles and may not be fully quantified by the FoS calculation, as they are driven by hydrological factors rather than slope-driven. For this reason, the locations need to be assessed on-site and 'ground-truthed' to identify true hazards. GDG site walkovers identified no evidence of significant bog burst features.

8.3.10.6 Overall Risk Rating

The procedure behind risk rating calculation is described in Section 6 of the PSRA report.

Risk for each Proposed Project infrastructure element is calculated. The risk rating ranges between 0 and 1 and the following levels of risk rating have been distinguished:

- High (0.6 to 1): Avoid project development at these locations. Mitigation is generally not feasible.

- Medium (0.4 to 0.6): The project should not proceed unless risk can be avoided or mitigated at these locations without significant environmental impact to reduce risk ranking to low or negligible.
- Low (0.2 to 0.4): Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations.
- Negligible (0 to 0.2): The project should proceed with monitoring and mitigating peat landslide hazards at these locations as appropriate.

All Proposed Project infrastructure elements are located mainly in areas of negligible risk with the exception of proposed turbine location T7 which is in an area of low risk as shown in Figure 8-6 and Figure 8-7 below.

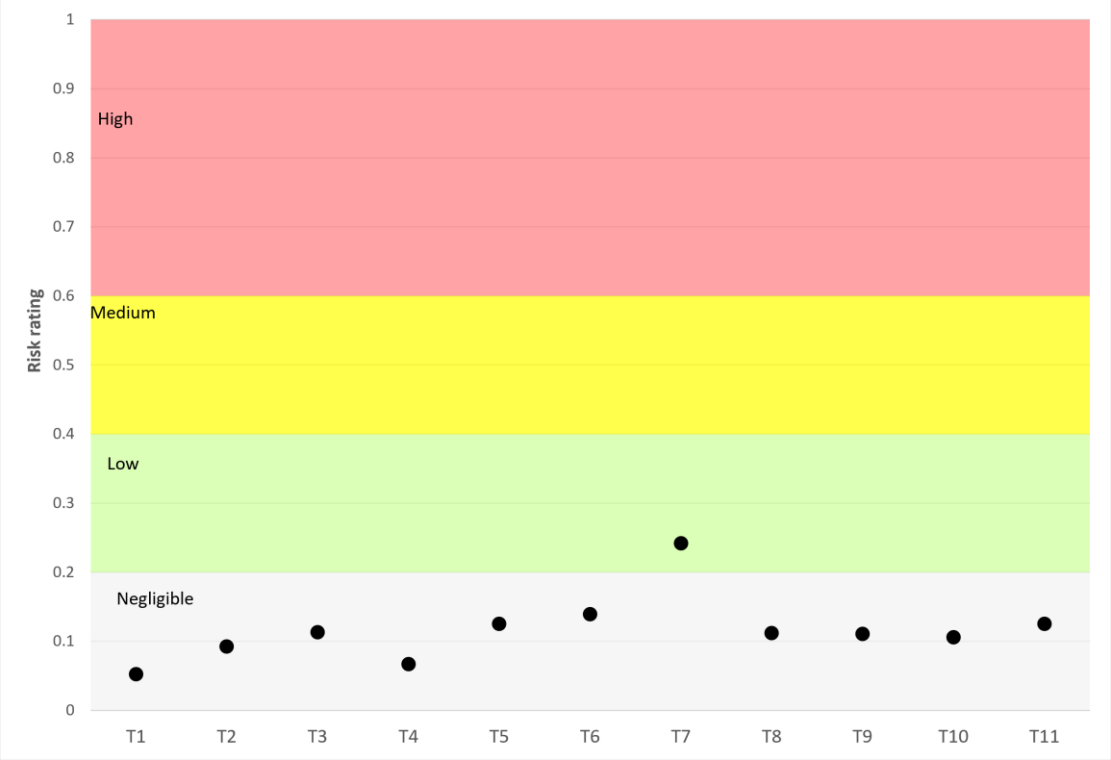

Figure 8-6 : Risk Rating at Proposed Turbine Locations (GDG, 2024)

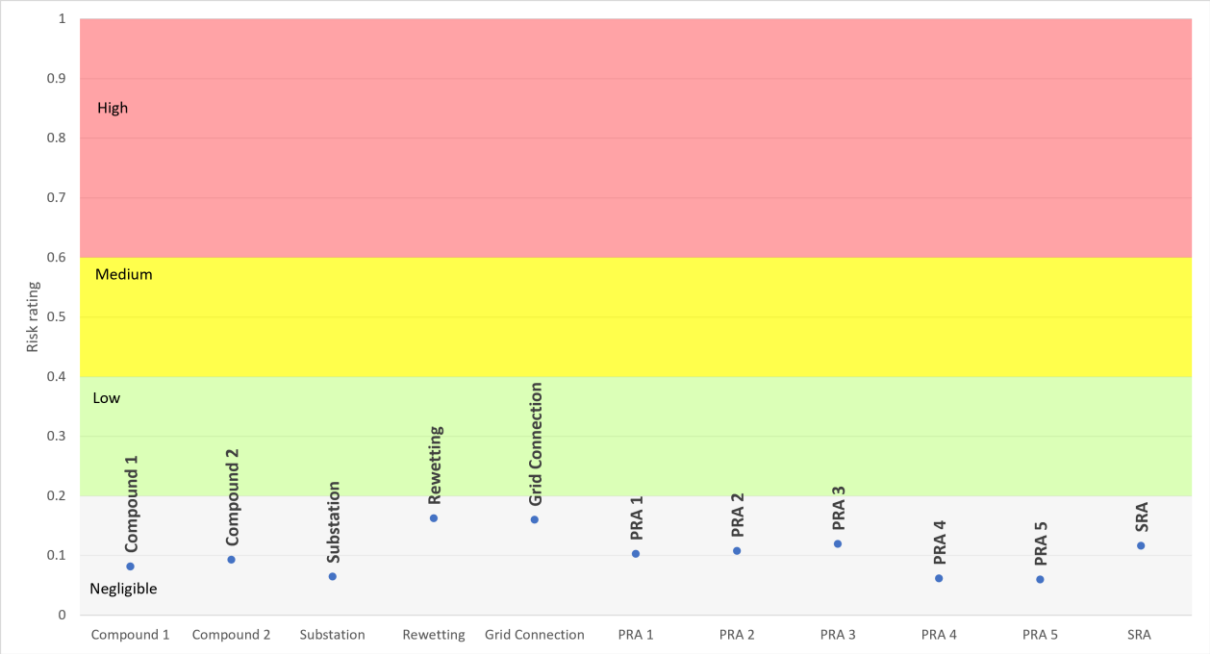

Figure 8-7 : Risk Rating at other Proposed Project Locations (GDG, 2024)

8.4 Characteristics of the Proposed Project

The Proposed Project construction will mainly involve removal of soils, peat and mineral subsoils for access roads, underground cabling, turbine hardstanding areas, turbine foundations, substation foundations, construction compound and drainage works. Crushed rock for construction purposes will be mainly sourced from an on-site borrow pit, with some material sourced from nearby commercial quarries. The estimated available rock volume is 106,770m^3 in the borrow pit.

Approximately 124,760m^3 of material will be required for the Proposed Wind Farm footprint with an estimated 106,770m^3 to be provided by the on-site borrow pit and 11,300m^3 of granular overburden won on site with the remaining 6,690m^3 to be imported from licenced quarries.

Generally during turbine construction, peat will be excavated to a competent stratum for the concrete turbine foundation and a small working area surrounding the foundation footprint. Turbine bases of 25m in diameter are proposed, with detailed foundation design dictated by the local ground conditions and the requirements of the turbine supplier.

Gravity foundations depths are expected to be between 3m and 3.5m deep, depending on ground conditions at each turbine location.

A piled foundation might be required at turbine locations on cutover bog due to the thick peat encountered, to be confirmed at the detailed design stage. This foundation will require the excavation of peat to a sufficient depth to allow the installation of the piling platform beneath the concrete foundation. The design of the turbine base foundations is subject to confirmatory ground investigation and assessment.

Piled foundation will require the excavation of peat to a sufficient depth to allow the installation of the piling platform beneath the concrete foundation. The design of the turbine base foundations is subject to confirmatory ground investigation and assessment.

At turbine locations T1, T2, T3 & T4, which are located inside the refined groundwater Zone of Contribution to the Gurteen/Cloonmore GWS spring, only a gravity base foundation (maximum depth 3 – 3.5m) or precast piling is being considered. These measures are proposed to protect groundwater quality and groundwater flows to the source spring (refer to Chapter 9 Water).

Similarly, all turbine crane hardstands will be founded on a suitable bearing material requiring the excavation of all peat and other soft ground materials, where present. The platform will be constructed in the excavated area using a suitable specified engineered stone fil. Following the placement of the platform, the excavated peat can be reused to batter the platform edges and landscape the platform back into the existing topography.

The total volume of peat and spoil (soil and subsoil superficial deposits) requiring placement/reinstatement within the Proposed Project site is estimated at 98,336m^3 (refer to Table 8-10 below).

The proposed peat and spoil reinstatement plan (along with volumes) is shown in Table 8-11 and Table 8-12 below.

Approximately 2,456m^3 of spoil from the borrow pit will be used for reinstatement and building drainage infrastructure at the borrow pit location and the remainder (12,000m^3) will be exported to a licenced waste facility.

Further details are provided in the Peat Management Plan for the works which is included in Appendix 4-3.

The purpose of this peatland enhancement process is to establish a hydrological regime, which will allow for the regeneration of an area of raised bog. The overall aim of the peatland enhancement plan is to put the selected bog area at the Site on a trajectory towards becoming naturally functioning peatland by rewetting the surface of the bog by raising the water table in the drain, and in adjacent areas primarily through drain blocking in order to reduce run-off rates and carbon losses.

Table 8-10: Summary of Excavated Peat and Spoil Volumes for Proposed Project

Infrastructure Item	Average Peat depth (m)	Excavated peat volume (m^3)*	Excavated spoil volume (m^3)
New Access Roads (founded)	0.3	16,060	350
Upgraded Access Road - including road to be widened (founded)	0.3	3,080	0
Cable Trenches	-	1,520	2,180
Turbine foundations	0.9	7,590	17,270
WTG Hardstand	0.7	18,480	0
Substation	0.2	3,520	13,830
Borrow Pit	0	0	14,456
Total		**50,250**	**48,086**

Note: The volume of peat material excavated has been estimated using the average peat depth calculated across the footprint of the structure to define the basal surface of the peat.

Table 8-11: Summary of Peat Reinstatement Volumes for Proposed Project

Comment	Peat Reinstatement volume (m^3)	Comments
New Access roads (founded)	13,270	Placement of arisings 2m^3/lin.m alongside existing and new founded roads, where topography allows.
New Access roads (floated)	3,190	
Upgraded Access roads (founded)	1,360	Placement of arisings 1m^3/lin.m alongside upgraded roads, where topography allows..
Upgraded Access roads (floated)	170	
Turbine foundations and hardstands (11no.)	5,050	Placement of arisings 3m^3/lin.m of external hardstand perimeter, where topography allows.
Compound (2no.)	1,290	Placement of arisings 3m^3/lin.m of external compound perimeter, where topography allows.
Substation	650	Placement of arisings 3m^3/lin.m of external substation perimeter, where topography allows.

Comment	Peat Reinstatement volume (m^3)	Comments
Peat Repository Areas	30,500	1m peat placement within peat repository areas, with a reduction to account for constructing a 3m cell berm.
Total	**55,480**	

Table 8-12: Summary of Spoil Reinstatement Volumes for Proposed Project

Comment	Spoil Reinstatement volume (m^3)
25% Reinstatement of Total Volume	6,740
Spoil Stockpile Areas	31,530
Total	**38,270**

8.5 Likely and Significant Impacts on Land, Soils and Geology

8.5.1 Do Nothing Scenario

If the Proposed Project were not to proceed, peat cutting and forestry plantation operations will continue and may be extended to occupy a larger portion of the Site. Forestry will be felled as forestry compartments reach maturity. Re-planting of these areas is likely to occur. Agricultural practices will continue.

The land, soils and geology would remain largely unaltered as a result of the Do-Nothing Scenario.

8.5.2 Likely impacts and Mitigation Measures – Construction Phase

The likely impacts of the Proposed Project and mitigation measures that will be put in place to eliminate or reduce them are shown below.

The impact assessment below assesses the overall Proposed Project as the Wind Farm and Grid Connection are not likely to be constructed as separate projects.

8.5.2.1 Effects on Land and Land use (Proposed Project)

There will be loss of land as a result of both the Wind Farm and Grid Connection (Proposed Project) and therefore both are assessed herein.

The loss of forestry amounts to 10.3ha, the loss of agricultural land amounts to 12.9ha and the loss of cutover bog amounts to 7.7ha.

There will be no effects on the lands adjoining the Proposed Project site. Turf cutting, agriculture and forestry will continue during the construction of the Proposed Project.

Pathway: Land take

Receptor: Land and Landuse (i.e. the land upon which the Proposed Project will occur)

Potential Pre-mitigation Impact: Negative, slight, direct, likely, permanent impact on land and landuse.

Impact Assessment:
The loss of agricultural, forestry land and cutover bog resulting from the Proposed Project on a local or regional scale is minimal and therefore the effects of actual agricultural land loss is imperceptible.

Mitigation Measures:

No mitigation is proposed with regard agricultural, peatland or forestry loss of land.

The total amount to be felled (10.3ha) accounts for only approximately 16.3% of the existing forestry and woodland coverage at the Site which is approximately 63ha.

The total loss of agricultural land (12.9ha) accounts for only approximately 8.4% of the existing agricultural land coverage at the Site which is approximately153.5ha.

The total loss of cutover bog (7.7ha) accounts for only approximately 13.4% of the existing bog coverage at the Site which is approximately 103.8ha.

Residual Impact: Due to the small footprint of the Proposed Project on a local scale the residual effect is negative, direct, slight, likely, permanent impact on land and landuse. The land and landuse along the Grid Connection underground electrical cabling route will not change.

Significance of Effects: For the reasons outlined above, no significant effects on land or landuse will occur as a result of the Proposed Project.

8.5.2.2 Peat, Subsoil and Bedrock Excavation (Proposed Project)

There will be excavations required for both the Wind Farm and Grid Connection (Proposed Project) and therefore both are assessed herein.

Excavation of soil, peat, subsoil and bedrock will be required for construction of works for the installation of access roads, foundations for turbine bases, crane hardstands, substation, construction compounds, grid connection cable, internal cable network and site drainage network.

This will result in a permanent removal and relocation of in-situ peat, soil and subsoil at most excavation locations. Estimated volumes of peat and spoil to be relocated are summarised above in Table 8-10. There will be no net loss of peat or subsoil, it will just be relocated within the Site.

Approximately 106,770m^3 of bedrock will be excavated from the borrow pit for Proposed Project construction purposes.

Pathway: Extraction/excavation.

Receptor: Peat, soil, subsoil and bedrock.

Pre-Mitigation Potential Effect: Negative, slight/moderate, direct, likely, permanent effect on peat, soil, subsoil and bedrock due to excavation and relocation within the Proposed Project site.

Proposed Mitigation Measures by Design:

- Placement of turbines and associated infrastructure in areas with shallower peat;
- Use of floating roads, where appropriate, to reduce peat excavation volumes;
- The peat and subsoil which will be removed during the construction phase will be localised to the wind farm infrastructure turbine location, substation and temporary compounds and access roads;
- The Proposed Project has been designed to avoid, insofar as possible, sensitive habitats within the Site; and,
- Construction of settlement ponds will be volume neutral, and all excess material will be used locally to form pond bunds and surrounding landscaping.

Residual Effect Assessment: The granular soil and peat at the Site can be classified as of "Low" importance and the bedrock of "Low" importance.

The overall Site area is extensive while the Proposed Project footprint (17.5ha) is approximately 5% of the overall EIAR Study Area of 353ha.

The design measures incorporated into the Proposed Project as described above in particular the avoidance of deeper peat areas combined with the 'low' importance of the deposits means that the residual effect will be negative, slight, direct, likely, permanent effect on peat, soil, subsoil and bedrock due to disturbance and relocation within the Site.

Significance of Effects: For the reasons outlined above, no significant effects on peat and subsoils will occur as a result of the Proposed Project.

8.5.2.3 Contamination of Soils by Leakages and Spillages of Hydrocarbons or Chemicals (Proposed Project)

Accidental spillage during refuelling of construction plant with petroleum hydrocarbons is a pollution risk at the Wind Farm and Grid Connection (Proposed Project) and therefore both are assessed herein.

The accumulation of small spills of fuels and lubricants during routine plant use can also be a significant pollution risk. Hydrocarbon has a high toxicity to humans, and all flora and fauna, including fish, and is persistent in the environment. Large spills or leaks have the potential to result in significant effects (i.e. contamination of peat, subsoils and pollution of the underlying aquifer) on the geological and water environment.

Pathway: Peat, soil and subsoil and underlying bedrock pore space.

Receptor: Peat, soil and subsoil, bedrock.

Pre-Mitigation Potential Effect: Negative, slight, direct, short-term, unlikely effect on peat, soil, subsoils and bedrock.

Proposed Mitigation Measures:

- On-site re-fuelling will be undertaken using a double skinned bowser with spill kits kept on site for accidental leakages or spillages;
- Only designated trained operatives will be authorised to refuel plant on-site;
- Taps, nozzles or valves associated with refuelling equipment will be fitted with a lock system;
- All fuel storage areas will be bunded appropriately for the duration of the construction phase. All bunded areas will be fitted with a storm drainage system and an appropriate oil interceptor. Ancillary equipment such as hoses, pipes will be contained within the bunded

area;
- Fuel, oil and chemical stores including tanks and drums will be regularly inspected for leaks and signs of damage;
- The electrical control building (at the substation) will be bunded appropriately to the volume of oils likely to be stored and to prevent leakage of any associated chemicals to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor;
- The plant used during construction will be regularly inspected for leaks and fitness for purpose;
- Safety data sheets for all chemicals used will be kept on-site; and,
- An emergency response plan for the construction phase to deal with accidental spillages is contained within the Construction and Environmental Management Plan (which is contained in Appendix 4.4).

Residual Effect Assessment: The use and storage of hydrocarbons and small volumes of chemicals is a standard risk associated with all construction sites. Proven and effective measures to mitigate the risk of spills and leaks have been proposed above and will break the pathway between the potential source and the receptor. The residual effect for the Proposed Project will be negative, imperceptible, direct, short-term, unlikely effect on peat, soil, subsoils and bedrock.

Significance of Effects: For the reasons outlined above, and with the implementation of the listed mitigation, no significant effects on peat, soil, subsoils and bedrock will occur as a result of the Proposed Project.

8.5.2.4 Erosion of Exposed Subsoils and Peat During Construction of Infrastructure (Proposed Project)

Peat, soils and subsoils are at risk of erosion at both the Wind Farm and Grid Connection (Proposed Project) during the construction phase and therefore both are assessed herein.

There is a high likelihood of erosion of peat and spoil during its excavation and during landscaping works at the Proposed Project site. The main impacts associated with this aspect is to the water environment, and therefore this aspect is further assessed in detail in Chapter 9.

Pathway: Vehicle movement, surface water and wind action.

Receptor: Peat, soil and subsoil.

Pre-Mitigation Potential Effect: Negative, slight, direct, short-term, likely effect on peat, soil and subsoils by erosion and wind action.

Proposed Mitigation Measures:

- The upper vegetative layer (where still present) of excavated peat will be stored with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the peat within the peat repository areas;
- Re-seeding and spreading/planting will also be carried out in these areas;
- Brash/bog mats will be put in place to support vehicles on soft ground, reducing peat and mineral soils erosion and avoiding the formation of rutted areas, in which surface water ponding can occur; and,
- A full Peat Management Plan for the development is included as Appendix 4-3 of this EIAR.

Residual Effect Assessment: Peat soils and spoil can be eroded by vehicle movements, wind action and by water movement. To prevent this all excavation works will be completed in accordance with a

detailed Peat and Spoil Management Plan, material will remain within the Proposed Project site and reseeding and planting will be completed to bind landscaped peat and spoil together. Following implementation of these measures the residual effects will be negative, slight, direct, short-term, likely effect on peat, soils and subsoils by erosion and wind action.

Significance of Effects: For the reasons outlined above, no significant effects on peat, soils, subsoils or bedrock will occur as a result of the Proposed Project.

8.5.2.5 Peat Instability and Failure (Proposed Project)

Peat instability and failure are risks at both the Wind Farm and Grid Connection (Proposed Project) during the construction phase and therefore both are assessed herein.

A Peat Stability Risk Assessment was carried out for the main infrastructure elements at the Proposed Project site. This approach takes into account guidelines for geotechnical/peat stability risk assessments as given in PLHRA (2017) and MacCulloch (2005).

Peat instability or failure refers to a significant mass movement of a body of peat that would have an adverse impact on the Proposed Project and the surrounding environment. The potential significant effects of peat failure at the Site may result in:

- Death or injury to site personnel;
- Damage to machinery;
- Damage or loss of infrastructure;
- Drainage disruption by blockage of drainage pathway by relocated peat and spoil;
- Site works damaged or unstable;
- Contamination of watercourses, water supplies by particulates; and,
- Degradation of the peat environment by relocation of peat and spoil.

However, the findings of the peat assessment, which involved analysis of 194 no. locations, showed that all Proposed Project infrastructure elements are located in areas of negligible to low risk as shown in Figure 8-6 and Figure 8-7 above.

Notwithstanding the above, the management of peat stability and appropriate construction practices will be inherent in the construction phase of the Proposed Project to ensure peat failures do not occur on site.

Pathway: Vehicle movement and excavations.

Receptor: Peat and subsoils.

Pre-Mitigation Potential Impact: The findings of the Peat Stability Risk Assessment showed that the Proposed Project site has an acceptable margin of safety, is suitable for the Proposed Project and is considered to be at negligible to low risk of peat failure.

Proposed Mitigation Measures:

Firstly, the key mitigation with regard peat stability risk at the Proposed Project site was the carrying out of a robust, multidisciplinary site investigation and peat stability risk assessment carried out in accordance with best practice guidance (PLHRA), Scottish Government, 2017).

The findings of the peat assessment, which involved analysis of 194 no. locations, showed that the Proposed Project areas have an acceptable margin of safety and that the site is suitable for the Proposed Project.

The peat stability risk assessment report provides a number of mitigation/control measures to reduce the potential risk of peat failure at each infrastructure location. Sections of access roads to the nearest infrastructure element will be subject to the same mitigation/control measures that apply to the nearest infrastructure element. The required mitigation/control measures are shown below:

The following control measures incorporated into the construction phase of the project will ensure the management of the risks for this site:

- Appointment of experienced and competent contractors;
- The site will be supervised by experienced and qualified personnel;
- Allocate sufficient time for the project (be aware that decreasing the construction time has the potential to increase the risk of initiating a localised peat movement);
- Prevent undercutting of slopes and unsupported excavations;
- Maintain a managed robust drainage system;
- Prevent placement of loads/overburden on marginal ground;
- Implementation of safety buffers around deep peat areas;
- Adhere to the spoil and peat management restriction areas detailed in the Peat Stability Risk Assessment Report (GDG, 2024);
- Set up, maintain and report findings from monitoring systems as outlined in the Peat Stability Assessment Report (GDG, 2024);
- Ensure construction method statements are developed and agreed before commencement of construction and are followed by the contractor; and,
- Revise and amend the Construction Risk Register as construction progresses to ensure that risks are managed and controlled for the duration of construction.

Please refer to Appendix 8-1 for details on the safety buffers and stockpile restrictions.

Residual Effect Assessment: A detailed Peat Stability Risk Assessment (GDG, 2024) (Appendix 8-1) has been completed for the Proposed Project. The findings of that assessment have demonstrated that there is a negligible to low risk of peat failure at the Site as a result of the Proposed Project. With the implementation of the control measures outlined above the residual effect is considered negative, imperceptible, direct, permanent, unlikely effect on peat and subsoils.

Significance of Effects: No significant effects on peat, soils and subsoils will occur.

8.5.2.6 Turbine Delivery Route Works (Wind Farm)

The TDR works only relate to the Wind Farm element and not the Grid Connection. Only the Wind Farm is assessed herein.

Minor earthworks are required for turbine delivery. These include for temporary widening of existing roads and junctions. These TDR works are described in Section 4.4 of the EIAR.

Pathway: Extraction/excavation/landscaping.

Receptor: Peat and subsoil

Potential Pre-Mitigation Impact: Negative, imperceptible, direct, likely, temporary effect on land, peat and subsoil.

Proposed Mitigation Measures:

- All works are minor and localised and cover very small areas;
- These works are distributed over a wide area; and,
- All works are temporary in nature.

Residual Impact: The TDR related earthworks are minor in nature and will be temporary in durations. They are also separated from each other by considerable distances. Residual effects of the Proposed Project are Negative, imperceptible, direct, likely, temporary effect on land, peat and subsoil.

Significance of Effects: For the reasons outlined above, no significant effects on land, soils or subsoils will occur.

8.5.2.7 Turbine Base Piling Works (Wind Farm)

The turbine base piling only relates to the Wind Farm element and not the Grid Connection. Only the Wind Farm is assessed herein.

It is proposed that turbine T7 will be a piled foundation as well as any turbines where the ground conditions require an alternative to gravity-based foundations.

For T1, T2, T3 and T4, pre-cast piles are the only alternative being considered at these locations if gravity foundations are not suitable. For the piled turbine foundation, a typical piling type and configuration could be between 45 to 60 no. 300mm square concrete driven piles.

Pathway: piling works.

Receptor: Soils and subsoils.

Pre-Mitigation Potential Impact: Negative, slight, direct, permanent likely effect on soils and subsoils by piling works.

Proposed Mitigation Measures:

Other than surface level and minor excavation works, any piling works will not produce significant volumes of spoil as the proposed piling system are driven piles (these will displace soil/subsoil within the ground).

No mitigation measures are proposed or required for soils and geology environment.

Residual Effect Assessment: The effects of piling works on soils and geology have been assessed. Pile install works would only result in small volumes of spoil, and minimal displacement of in-situ subsoils. This small displacement would not alter ground levels, nor change the local geological environment in any significant way. As such the residual effects of the Proposed Project are negative, direct, imperceptible, permanent, likely effect on soil and subsoils by piling works.

Significance of Effects No significant effects on soils and subsoils will occur.

8.5.2.8 Peatland Enhancement (Wind Farm)

The proposed Peatland Enhancement is associated with the Wind Farm element and not the Grid Connection. Only the Wind Farm is assessed herein.

The purpose of this Peatland Enhancement process is to establish a hydrological regime, which will allow for the regeneration of an area of raised bog. The overall aim of the peatland enhancement is to put the selected bog area at the Site on a trajectory towards becoming naturally functioning peatland by rewetting the surface of the bog by raising the water table in the drains, and in adjacent areas primarily through drain blocking in order to reduce run-off rates and carbon losses.

Pathway: Rewetting measures and targeted revegetation.

Receptor: Peat

Pre-Mitigation Potential Impact: Positive, slight, direct, permanent likely effect of Peatland Enhancement.

Mitigation Measures:

To maximise the effectiveness of the re-wetting proposal and to increase the chances of future success, any works undertaken as part of the enhancement works will be based on approaches and methods that were successful at other peatland sites in Ireland.

Peat water level monitoring, by means proposed piezometer installs, will also be carried out to monitor the effectiveness of the bog re-wetting. The monitoring will continue through the lifetime of the Proposed Project.

Likely Residual Effect: The likely residual effect of the Proposed Project on peat following the implementation of the Peatland Enhancement is a moderate, positive, direct, permanent effect on peat as it will be wetter and closer to its natural condition with increases in vegetation cover across all bogs.

8.5.3 Operational Phase - Likely Significant Effects and Mitigation Measures (Proposed Project)

There are very few potential direct impacts are envisaged during the operational phase of the Proposed Project. The potential impacts may include:

- Some construction vehicles or plant may be necessary for maintenance of turbines which could result in minor accidental leaks or spills of fuel/oil;
- The transformer in the substation and transformers in each turbine are oil cooled. There is potential for spills / leaks of oils from this equipment resulting in contamination of soils and groundwater; and,

In relation to indirect impacts a small amount of granular material may be required to maintain access tracks during operation which will place intermittent minor demand on local quarries.

None of these potential impacts will be significant, as they are of such small scale and also of an intermittent nature.

Mitigation measures for land, soils and geology during the operational phase include the use of aggregate from authorised quarries for use in road and hardstand maintenance. Oil used in transformers (at the substation and within each turbine) and storage of oils in tanks at the substation could leak during the operational phase and impact on ground/peat and subsoils and groundwater or surface water quality. The substation transformer will be in a concrete bunded capable of holding 110% of the stored oil volume. Turbine transformers are located within the turbines, so any leaks would be contained within the turbine.

In addition, automated oil leak detectors will be placed in each of the turbines which will allow early detection of even the smallest leaks of oil or hydraulic fluid that may arise from components such as the transformer or gearbox. The automated detection system will then rapidly notify the wind farm operator by cloud-based systems. This early detection system will prevent large leaks of oil or hydraulic fluid.

These mitigation measures are considered sufficient to eliminate potential risks to ground/peat/soils and subsoils, and groundwater and surface water quality.

8.5.4 Decommissioning Phase - Likely Significant Effects and Mitigation Measures (Proposed Project)

The potential effects associated with decommissioning of the Proposed Project will be similar to those associated with construction but of reduced magnitude.

During decommissioning, it will be possible to reverse or at least reduce some of the potential impacts caused during construction by rehabilitating construction areas such as turbine bases, hard standing areas. This will be done by covering with peatland vegetation/scraw or poorly humified peat to encourage vegetation growth and reduce run-off and sedimentation. Other impacts such as possible soil contamination by fuel leaks will remain but will be of reduced magnitude. However, as noted in the Scottish Natural Heritage report (SNH) Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms (SNH, 2013) reinstatement proposals for a wind farm are made approximately 30 years in advance, so within the lifespan of the wind farm, technological advances and preferred approaches to reinstatement are likely to change. According to the SNH guidance, it is therefore:

> *"best practice not to limit options too far in advance of actual decommissioning but to maintain informed flexibility until close to the end-of-life of the wind farm".*

Mitigation measures applied during decommissioning activities will be similar to those applied during construction phase as shown in Section 8.5.2 above.

Some of the impacts will be avoided by leaving elements of the Proposed Project in place where appropriate. The substation will be retained by EirGrid. The turbine bases will be rehabilitated by covering with local topsoil/peat in order to regenerate vegetation which will reduce runoff and sedimentation effects. Internal roads will remain as amenity pathways and forestry access roads. Mitigation measures to avoid contamination by accidental fuel leakage and compaction of soil by on-site plant will be implemented as per the construction phase mitigation measures.

No significant effects on the land, soils and geological environment will occur during the decommissioning stage of the Proposed Project.

8.5.5 Risk of Major Accidents and Disasters

Due to the nature of the Proposed Project site, *i.e.* soft peat deposits, there is a risk of peat movement occurring. However, due to the generally flat nature of the Site, the risk is low.

A comprehensive Peat Stability Risk Assessment (GDG, 2024) has been undertaken for all Proposed Project infrastructure locations, and it concludes that with the implementation of the proposed control (mitigation) measures. The residual effect of a landslide occurring is determined to be imperceptible.

8.5.6 Human Health Effects

Potential health effects arise mainly through the potential for soil and ground contamination. The Proposed Project is not a recognized source of pollution (e.g. it's not a waste management site, or a chemical plant), and so the potential for effects during the operational phase is very low.

Hydrocarbons will be used onsite during construction; however, the volumes will be small in the context of the scale of the Proposed Project and will be handled and stored in accordance with best practice mitigation measures. The potential residual effects associated with soil or ground contamination and subsequent health effects are imperceptible.

Peat failure has also the potential to affect human health, but this would likely require a catastrophic failure to occur. The residual risk of significant peat slide/failure occurring is determined to be negligible to low following the implementation of the proposed control (mitigation) measures.

8.5.7 Cumulative Effects

The potential for impact between the Proposed Project, and other relevant developments has been carried out with the purpose of identifying what influence the Proposed Project (Proposed Wind Farm and Proposed Grid Connection combined) will have on the surrounding environment when considered cumulatively and in combination with relevant existing permitted or proposed projects and plans in the vicinity of the Site, as set out in Chapter 2 of this EIAR. Please see Section 2.8 of Chapter 2 for cumulative assessment methodology.

8.5.7.1 Construction Phase

The nature of the construction works within the Proposed Project site mean that the effects on the land, soils and geology environment are restricted to the immediate areas of the construction works. The only cumulative effect of the Proposed Project with respect to the lands, soils and geology will be due to the potential removal and transport of material to a licensed waste facility, where required. The environmental effects of the placement of material within the licenced waste facility will have been previously assessed during the licensing process of this facility. There will be no further cumulative effects on the land, soils and geology environment during the construction phase of the Proposed Project.

8.5.7.2 Operational Phase

During the operational phase of the Proposed Project all aspects of the land, soils and geology environment will remain constant, with no alteration of any aspect of this environment. As a result, there will be no cumulative effects due to the Proposed Project.

8.5.7.3 Decommissioning Phase

During the decommissioning phase of the Proposed Project, there will be minimal disturbance of soil/subsoil. The underground electrical cabling ducts will be left in-situ (cables removed by re-opening the joint bays used for the installation of the cabling) and turbine foundations will not be removed but covered over with soil/subsoil. These works will be limited in scale and there is no potential for cumulative effects with other nearby developments.

8.5.8 Post Construction Monitoring

Peat water level monitoring, by means proposed piezometer installs, will also be carried out to monitor the effectiveness of the bog re-wetting associated with the Peatland Enhancement. The monitoring will continue through the lifetime of the Proposed Project.